heated soil is manifestly very different from a decoction of untreated soil; it contains much larger quantities of dissolved substances and may be expected to behave differently as a medium for bacterial development. The experiment proves conclusively that heating a soil to 250° F. causes decomposition, but I can not see that it helps us to find out what is going on in an unheated soil. The authors go on to say that protozoa are "uncommon in their soils" and "very few forms were found." It would be interesting to find what is the difference between their soil conditions and those at Michigan where Dr. Rahn[7] found protozoa of the same types occurring in numbers of the same order per gram as we find at Rothamsted.

Professor G. T. Moore, writing in SCIENCE,[8] disagrees wholly and absolutely with our work; indeed he thinks that in the tangled maze of microbiological problems "the one fact which does seem to be fairly well established is that the temporary removal from the soil of the protozoa has but little bearing on the problem." We should not feel that we had lived in vain if we had merely been the humble instruments by which such a proposition was established, but again we are not satisfied as to the evidence. Professor Moore asserts that soil protozoa are not killed by toluene, carbon disulphide, etc., but are only temporarily depressed, and after three days their numbers may equal or even exceed those originally present. Never on any occasion have we observed anything of this kind.

In an admirable paper[9] on the effects of heat on the soil Drs. Seaver and Clark attribute to us the claim that the increased productiveness of heated soils is due to the destruction of protozoa. We wish to point out that we have always regarded the destruction of detrimental organisms as only one factor in the case, and have fully recognized the effects of the decomposition brought about by the heat. In order to minimize these decomposition effects we generally treat our soils with vapors of antiseptics rather than by heat, but here also we do not lose sight of the possibility of other changes being induced besides the destruction of life.

Finally, we may be allowed to remind the reader that the adverse effect of our detrimental organisms is on the numbers of bacteria, but that the relationship of bacterial numbers to soil fertility is by no means simple. Fertility is determined by any of the factors capable of limiting plant growth. In some soils it may be the supply of phosphates, of potash, of water that is inadequate; if so, soil bacteria may show little or no connection with fertility. Only when the supply of nitrogen compounds becomes a limiting factor do the soil bacteria come in, and even then the relationship between their numbers and their activity is not quite straightforward. We have traced out this problem in detail in our paper in the *Journal of Agricultural Science*, 1913, p. 152.

We do not underrate the complexity of soil fertility problems and, above all, we do not assert that our destructive organisms are the only things involved in the matter, but we do claim that they are an important factor. Our only hope of getting any further with the complex problems of the soil is to study the factors one at a time. We must not be confused by the circumstances that other factors remain to be studied, nor, on the other hand, must we lose sight of the possibility that these other factors may vitiate some of our experiments.

E. J. RUSSELL
ROTHAMSTED EXPERIMENTAL STATION,
HARPENDEN, ENGLAND

[7] *Centr. Bakt. Par.*, 1913, 36: 419–421.

[8] November 8, 1912.

[9] *Biochemical Bulletin*, 1912, 1: 413.

TWO ADDITIONS TO THE MAMMALIAN FAUNA OF MICHIGAN

THE northern pine vole, *Microtus pinetorum scalopsoides* (Audubon and Bachman) has apparently not been recorded from Michigan, and up to last year no Michigan specimen had been secured by the museum. In April, 1912, a specimen (No. 42,558, Museum of Natural History, University of Michigan) was taken by W. A. Brotherton, near Rochester, Oak-

land County, and since that time the writer has examined two specimens from the collection of the Michigan Agricultural College, both of which were secured near East Lansing, one on April 20, 1901, by D. S. Bullock, and the other in August, 1896, by T. L. Hankinson.

Another species apparently new to the Michigan fauna is Richardson's shrew, *Sorex richardsonii* Bachman, a specimen of which, taken at Chatam, Alger County, August 28, 1900, is in the collection of the Michigan Agricultural College. Although Seton[1] includes the northern peninsula in his map of the range of the species, the writer can find no recorded localities nearer than Oneida County, Wisconsin,[2] and the north shore of Lake Superior. Northern Michigan has probably been included in the range because this region formed a part of the "Northwest Territory"; it is not included by Merriam.[3]

The museum is indebted to the U. S. Biological Survey for verifying the identification of the specimens mentioned, and to Professor W. B. Barrows, for the loan of the specimens in the Michigan Agricultural College.

NORMAN A. WOOD
MUSEUM OF NATURAL HISTORY,
UNIVERSITY OF MICHIGAN

[1] "Life Histories of Northern Animals," Vol. II., p. 1107.

[2] Hartley H. T. Jackson, *Bull. Wisconsin Natural History Society*, 1908, pp. 30–31.

[3] "North American Fauna," No. 10, p. 48.

INTERGLACIAL RECORDS IN NEW YORK

IN Professor H. L. Fairchild's most interesting address on "Pleistocene Geology of New York State" the following statement appears:[1]

> The accepted facts of multiple glaciation in the Mississippi basin coupled with proofs of Prewisconsin drift in Pennsylvania and New Jersey and on Long Island, with accumulating evidences in New England, demands the theoretical acceptance of at least dual glaciation for New York state. But the positive proof, in the field, of a Prewisconsin ice sheet has not been found.

A few years ago, Miss Maury[2] reported an interglacial deposit at the south end of Cayuga Lake, on the west shore between "Taughannock Falls and Frontenac Beach in a small ravine which has cut through one of the delta terraces so common in Cayuga Valley." An exposure gave the following vertical section:

Drift	20 to 30 feet.
Gravel and sand	several inches.
Fossiliferous clay	10 to 15 feet.
Bowlder clay	10 to 15 feet.
Devonian shales	10 feet above lake level.

The lower bowlder clay is thought to represent the Illinoian invasion and is oxidized, indicating a period of exposure to the air and hence of erosion. The lower deposits are peaty and contain a quantity of plant remains. The upper fossiliferous deposits are a slaty blue clay in which mollusks to the number of eighteen species are found in abundance. Twelve of these molluscan species are also found in the interglacial Don beds of Toronto, and the lake in which these animals lived was doubtless contemporaneous with the large Ontarian Lake in which the Don mollusks lived. The thickness of the clay deposits (10–15 feet) indicates a long period of deposition.

In the Watkins Glen-Catatonk Folio of New York,[3] page 26, reference is made to an older drift in Watkins Glen, underlying 100 feet of Wisconsin drift. In the blue clay underlying the drift and overlying a bed of sand and gravel, the leaf of an arctic willow (*Salix reticulatus*) was found. Though this deposit is stated by the authors to have probably been laid down during the advance of the Wisconsin ice sheet, the inference is strong, in view of the Cayuga Lake and the Toronto interglacial deposits, in favor of its being contemporaneous with the Scarboro beds near Toronto which contain cold climate animals and plants, including an undermined willow (*Salix* sp.). The evidence of this Cayuga Lake deposit appears to be quite as conclusive as is that of the Toronto deposits.

[1] SCIENCE, XXXVII., No. 946, p. 238.

[2] *Journal of Geology*, XVI., pp. 565–567, 1908.

[3] Geologic Atlas, No. 169, 1909.